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PATENT

COMPUTER SYSTEM EMPLOYING COMBINED TAG READER AND WIRELESS MANUAL INPUT DEVICE

RELATED APPLICATION INFORMATION

The present application claims priority under 35 USC 119 (e) to provisional application serial no. 60/257,479 filed December 21, 2000, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

The present invention relates to wireless data input devices and controllers and computer systems employing wireless data input devices and controllers. The present invention further relates to methods of wireless data entry and control of computer systems.

2. Description of the Prior Art and Related Information

Passive transponder RF identification (RFID) systems are becoming prevalent in a variety of applications including security access systems, product tracking and inventory control systems, contactless smart cards, and a variety of other applications. These various RFID systems employ RFID tags, either attached to a product or embedded in a card, and readers which include interrogating antennas and reader electronics to interrogate the tags and decode the tag transponder signals. These reader components inevitably add costs to each location where the tags are interrogated. These tag reader costs may be relatively unimportant in high end systems where many tags are screened by a single reader, such as at a commercial warehouse or retail inventory screening application. These reader costs are typically borne by a large retail or commercial

operation and the reader costs may be less important than the costs of the tags themselves. These reader costs may be much more significant, however, where they will be borne by a consumer or are part of a lower volume application. Therefore, the costs of a reliable tag reader can be a significant barrier to applications involving consumers or end users bearing the equipment costs, such as personal contactless smart card readers, personal RFID security systems and RFID Internet navigation systems. Similarly, these costs can be a barrier to small volume applications of RFID tags such as small business applications. Accordingly, a need presently exists for a way to reduce costs of RFID tag readers in low volume or end user applications.

Wireless data input devices and controllers for computers are also becoming increasingly popular. In particular, wireless mouse controllers and wireless keyboards have a number of advantages over the more common wire connected mouse controllers and keyboards employed in computer systems. First of all, wireless mouse controllers and wireless keyboards offer more flexibility to the user to position him or her self relative to the computer. This can reduce strain and tiredness associated with computer use. Also, wireless mouse controllers and wireless keyboards reduce the amount of wires connected over or around a desktop and reduce clutter and complicated wiring tangles. This also creates a cleaner look to the overall system and can give the computer system a more sophisticated and/or expensive look. This avoidance of wiring becomes increasingly significant as more add on peripherals are included in typical computer systems which can result in workplace clutter.

The wireless mouse controllers and wireless keyboards currently available are either infrared based or RF based transmission systems. The infrared systems are the simplest and least expensive, however, they require a line of sight to the receiver. This can result in inconsistent transmission as the mouse controller or wireless keyboard is moved or if other objects block the transmission path. RF systems do not suffer from this problem but are more expensive than infrared

systems. In particular, the reliability of transmission in RF systems at a given range depends on the RF frequency and the power and quality of the transmitter. Therefore, maintaining transmission reliability requires more expensive higher frequency transmitters and/or higher power transmitters. Nonetheless, RF systems are increasingly being used for wireless mouse controllers and wireless keyboards over infrared systems due to their performance advantages despite the RF component costs.

SUMMARY OF THE INVENTION

In one aspect the present invention provides a computer system adapted for use with a separately provided RFID tag having data stored therein. The computer system comprises a monitor, a processor, and a wireless manual input device. The wireless manual input device includes an antenna and an RF circuit coupled to the antenna and providing an RF signal identifying manual user input. The computer system further comprises a shared reader including an antenna for receiving RF signals from the RFID tag and wireless manual input device and a decoder for detecting the data sent from the RFID tag passive transponder circuit and the manual user input information from the RF circuits. The wireless manual input device may, for example, comprise a wireless mouse or a wireless keyboard.

Further aspects of the present invention will be appreciated from the following description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective drawing of a computer system incorporating a combined tag reader and wireless mouse in accordance with the present invention.

Figures 2A and 2B, are a top sectional view of a detailed structural implementation of a wireless mouse and side view of an encoder wheel, respectively, in accordance with the present invention.

Figure 3 is a schematic diagram of an alternate embodiment of the tag circuitry adapted for a wireless mouse in accordance with the present invention.

Figure 4 is a block diagram of the shared reader electronics employed in the computer system of Figure 1.

Figure 5A and 5B are schematic diagrams of an alternate embodiment with the reader antenna incorporated in a mouse pad.

Figure 6 is a perspective drawing of a computer system incorporating a combined tag reader and wireless keyboard in accordance with an alternate embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to figure 1, a computer system 10 incorporating a combined tag reader and wireless mouse 12 is illustrated. The computer system as illustrated also includes a housing 14 which includes the processor, hard disk drive, and other components in a conventional computer system, as well as a reader unit which is the source of an interrogating field 16 which is used to read data from RF transponders 15 (referred to as tags herein) presented within the field read region and to continuously interrogate the mouse 12. The computer system also includes a monitor 18 which may be a CRT or LCD type of display or other display known in the computer art. Interrogating field 16 is an RF modulated field generated by the reader and applied to a suitable antenna 52, contained within a mouse pad (described below) or within housing 14 (two possible configurations being illustrated). Optionally the reader and/or the antenna may be contained within monitor 18. Although the reader electronics is preferably contained within the computer housing or in the monitor it may be incorporated in an add-on unit which interfaces with the computer housing 14 through an available port, such as a USB port, or the mouse input.

Passive transponder tags as well as readers suitable for energizing and reading the response from such tags are well known and commercially available from a number of sources. Transponder tags typically include an antenna and a data memory in a compact IC. Transponder tags and readers employ electromagnetic coupling between the reader and tag antenna to both power the tag and transfer data. Examples of passive ID tags and readers which may suitably be employed in the present invention are described in the following United States patents; U.S. patent No. 6,040, 773 to Vega, et al., U.S. patent No. 5,446,447 to Carney et al., U.S. patent No. 6,107,920 to Eberhardt et al., U.S. patent No. 6,100,804 to Brady et al., U.S. patent No. 6,072, 383 to Gallagher et al., U.S. patent No. 4,730,188 to Milheiser, and U.S. patent No. 5,430,441 to Bickley, et al., the disclosures of which are incorporated herein by reference in their entirety.

Tags 15 may be attached to a variety of different items 17 and when read by the tag reader the stored data may provide any of a variety of different information to the computer system. For example, tags 15 may be attached to documents or files and the stored data provides document or file tracking and data entry in an office setting. For example, the tag 15 may be attached to a file folder and when passed in range of the tag reader the read data provides a list of the folder's documents from the tag memory to the computer document management software. Alternatively, tags 15 may contain data linked to the internet. For example, tags 15 may be attached to a variety of different products or product documentation and when read by the tag reader the tag data provides URLs to the computer browser to take the browser to the product web site or related web sites. This capability may be associated with new products, for example allowing ease of warranty registration for new products by a consumer or ease of access to additional product information or websites of related interest. Also, this tag data may be used for a variety of other uses such as linking sales or promotional materials to web based sales sites, links to product repair information or even diagnostics for intelligent appliances equipped with writable tags.

The transponder 15 may also be incorporated as part of a contactless smart card 17. Such smart cards are employed in a variety of applications which may advantageously use a convenient PC interface. For example, smart cards may contain credit card, bank debit card or other financial information and be used for internet based transactions. Smart cards may also provide other personal records or other information. Smart cards may also provide security protection for computer network access at a local or internet level via the computer system. These and a variety of other smart card applications may use the computer system with the smart card reading system described herein. Detailed specifications for contactless smart cards are set out in ISO/IEC specification 15693 the disclosure of which is incorporated herein by reference. Also smart card 17 may be a hybrid contact/contactless card such as described in US Patent

No. 5,999,713 the disclosure of which is incorporated herein by reference. The computer system may also optionally employ a contact reader 19 to provide the ability to read both contact and contactless cards or to write to a hybrid card using a contact mode and read using a contactless mode.

The tag reader also continuously interrogates wireless mouse 12 and obtains mouse pointer information. Mouse 12 provides XY pointer information to the reader and the computer by employing two or more passive transponders (X/Y transponders) which receive energy from the interrogating field 16 and provide a coded response to the reader which indicates the mouse motion. As noted above suitable passive transponder designs are known and are described in the above noted patents. The X/Y transponders in the mouse are modulated by an X or Y encoder wheel, respectively, and provide a modulated response to the reader in the computer housing 14 corresponding to motion of the X or Y wheels. Each transponder identifying the X or Y wheel/direction is uniquely identified by the reader, either based on a unique resonant frequency for the transponder, a unique time slot for the tag, or a unique coded responder signal by the tag and thus provides an identification of the specific X/Y mouse motion to the computer processor.

The mouse also preferably includes left and right mouse buttons 22, 23. Each button is coupled to a passive transponder tag which receives energy from the interrogating field 16 and when activated provides a coded response to the reader which indicates the button activated. Specifically, in a preferred embodiment the activation of a mouse button closes a switch that connects the transponder IC corresponding to that button to its antenna thereby allowing it to receive energy from the interrogating field 16 and provide a coded response to the reader. Since each transponder corresponding to a given mouse button has a unique code identifying the button, which code is read by the reader, this provides an identification of the specific mouse button activation to the computer

processor. Alternatively, each button may be associated with a tag tuned to a different resonant frequency thereby identifying the button to the reader.

Referring to figures 2A and 2B, a detailed structural implementation of wireless mouse 12 is illustrated in a top sectional view. Mouse 12 includes a housing 20 with a conventional mouse ball 24 configured in an opening in the bottom of the housing. X and Y encoder wheels 34, 35, respectively, are configured to rotate with the mouse ball, also in a conventional manner. Passive transponders 30 and 32 are configured adjacent the perimeter of the respective encoder wheels 34, 35 and are modulated by a pattern 37 on the encoder wheel. This tag modulation encodes the wheel motion and is relayed to the reader by the transponder. Alternatively, each of the transponders may be coupled to a sensor, which is configured adjacent a respective encoder wheel (i.e., configured at the tag position in figure 2A and 2B), which sensor is responsive to the pattern 37 and modulates a switching circuit in the transponder.

For example, such transponder modulation may be by tuning/detuning of the transponder. Passive transponders are tuned so they resonate at a particular interrogating RF frequency. Such tuning of transponders to a specific interrogating frequency is known in the art, see for example the `447 patent and `383 patent. Such tuned transponder circuits may include capacitive and/or inductive elements. Preferably the transponders 30, 32 are responsive to different interrogating frequencies and are tuned such that presence of a conductive, inductive or magnetic repeating pattern 37 coating the surface of the wheels 34, 35 will cause the transponder circuit to be activated (or deactivated) only when pattern portions are aligned over the transponder. For example the pattern 37 could simply be a pattern of conductive or magnetic stripes on the perimeter of wheels 34, 35 as illustrated in figure 2B. An oriented or suitably positioned inductor, capacitor electrode or other magnetic or electrically sensitive circuit element may be provided in the tuning circuits of transponders 30, 32 so that the tuning and activation of each transponder tracks the motion

of the respective wheels 34, 35. Therefore, as the mouse ball 24 is rotated the two transponders will be tuned and detuned repeatedly with a duty cycle which corresponds to the X and Y motion of the rotating mouse ball. This thus provides the conventional X and Y information of the mouse ball which can be used to provide the conventional mouse control functions by the PC.

Alternatively the motion of the X and Y wheels may be encoded in data sent by the transponders to the reader, e.g., with an encoder stripe over the tag encoded as a "1" and the absence of a stripe as a "0". This 0 or 1 data may be transferred at a much higher rate of data transfer than the encoder wheel pattern and the tag can effectively be continuously on; i.e., always tuned and powered. Although the tag data transfer itself may involve duty cycling the tag on and off, any such duty cycling will be of short duration relative to encoder wheel motion. This always on approach may increase read speed and allow greater encoder accuracy. In this approach the tags will incorporate or be coupled to a switching circuit which is responsive to the wheel through a sensing element and controls the data state as a 0 or 1. This sensing element may also use magnetic or electric coupling of the types noted above, a Hall effect or magneto resistive sensor, or other known sensor. Also a mechanical rotary encoder switch may be used.

Figure 3 illustrates yet another approach where the tags are duty cycled by the encoder wheels via switch 38 coupled to antenna 39 (a similar connection for tag 32 and antenna 41 is also provided, not shown). A switch of any type responsive to wheel motion may be employed. Also, a sensor 33 responsive to pattern 37 may be coupled to switch 38. For example, magnetic strips 37 on the wheel could induce a current in a coil in the switch sensor 33 adjacent the wheel closing switch 38 based on wheel motion.

The mouse also includes passive transponder tags 25, 26 corresponding to the left and right mouse buttons. Tags 25, 26 also receive energy from the

interrogating field 16 and when activated provide a coded response to the reader which indicates the button activated. Specifically, in a preferred embodiment the activation of a mouse button closes a switch 27 or 28 that connects the transponder IC corresponding to that button to an antenna thereby allowing it to receive energy from the interrogating field 16 and provide a coded response to the reader in the computer housing 14. Since each transponder corresponding to a given mouse button has a unique code identifying the button, which code is read by the reader, this provides an identification of the specific mouse button activation to the computer processor. Since the two buttons are not simultaneously activated a shared antenna 29 may be used.

All the noted tags and antennas may be mounted on a single PCB 31 in a simple and inexpensive construction. Although the antennas 29, 39 and 41 are illustrated as planar, and such design may be suitable for electric field based readers, other antenna designs, such as coils for inductive readers may be employed.

Referring to figure 4 a reader block diagram is illustrated. As noted above reader designs are known and are described in the above patents and need not be described in detail herein; however, figure 4 illustrates aspects of the reader adapted for the present application. As shown the reader includes a mouse button reader and decoder 40, X and Y reader and decoders 42,43, and tag reader and decoder 45. These may each be operable at frequencies f1, f2, f3, and f4 respectively. (A single frequency for the mouse buttons may be employed since these buttons are normally not simultaneously operated and will not interfere or confuse the reader.) A swept frequency may be generated by the reader instead of separate frequencies, for example, as set out in US Patent No. 5,866,891, the disclosure of which is incorporated herein by reference. The XY decoders in turn may use two frequencies for the two transponders since these will be simultaneously operated as described above. Frequency isolation by a reader is disclosed in the `447 patent and the reader of figure 4 and decoders 40,

42, 43,45 may incorporate features of, e.g., figure 14 of the `447 patent for frequency isolation and decoding.

Other techniques for preventing interference from multiple transponders being read simultaneously may be employed instead of assigning unique frequencies to the commonly activated transponders. For example, a protocol where each tag is allotted a unique time slot can minimize inter-tag interference without separate frequencies. Also, different approaches may be combined; for example, with one frequency for the reading of tags 15 and a second common frequency for the transponders on the mouse 12. In this approach one or all of the transponders in the mouse, i.e., transponders 25, 26, 30, 32, are preferably continuously on and deriving a clock signal from the RF field from the reader. This clock signal is used to define separate time slots for each of the transponders. The time division multiplexing of the transponders based on this clock signal may be controlled by one of the transponders (master) which is coupled to the other (slave) transponders on the mouse and switches them to transmit or not on a multiplexed basis; or a separate mux control circuit which is always on and controls the individual transponders may be provided on the mouse. Alternatively, the reader may encode the mux control signal in the RF interrogating field. For example, the reader may consecutively place one of five different mux codes on consecutive time slots with each of the transponders responding to a matching code and in a matching time slot. Such mux control codes and/or timing signals may be provided by mux control circuitry 47 to the reader antenna and/or the decoders 40-45.

The decoded button and mouse information is provided to control processing circuit 44 which converts the decoded information to conventionally formatted key and mouse control data which is provided to the computer processor on line 46. Some or all of the functions of circuit 44 (as well as some functions of decoders 40, 42, 43,) may be provided in the computer processor, however, and this may provide cost advantages. The decoded tag data from tag reader and decoder 45

is provided to the computer for processing with the computer browser or specific tag software.

Referring to figure 5A and 5B an embodiment is shown with the reader antenna 52 incorporated in a mouse pad 50. The bulk portion of mouse pad 50 is composed of a dielectric material with antenna 52 embedded therein. The antenna 52 is coupled to the reader via cable 54. This configuration provides strong coupling between the read antenna and the tag antennas in mouse 12. Since the mouse is closely spaced to the read antenna 52 an effective read field distance may be chosen relatively short, e.g., about 6-12 inches. This may provide positive tag 15 reading by simply passing the tag 15, or product 17 incorporating tag 15, over the mouse pad antenna 52 within the read distance. This will avoid accidentally reading tags in the general vicinity of the reader and only tags desired to be read will be read.

Referring to figure 6 the tag reader may also be used in a computer system 10 having a wireless keyboard with a shared reader interrogating the tags 15 and the keyboard or the tags, keyboard and mouse. For example, mouse 12 may be implemented as a trackball in a keyboard 60 or may be separate from the keyboard and still share the reader. In the latter implementation the reader antenna illustrated in figure 5 may optionally be employed alone or in combination with a second read antenna in the housing 14. Keyboard 60 may be a QWERTY keyboard of an integral one piece conventional construction or may incorporate a folding design such as disclosed in U.S. patent No. 6,094,156 the disclosure of which is incorporated herein by reference in its entirety. Keyboard 60 includes an RF circuit which may comprise one or more passive transponder circuits which receive energy from the interrogating field 16 and when activated provides a coded response to the reader which indicates the key activated. As discussed above, suitable passive transponders are known and typically include an antenna and integrated circuit. The antenna is used by the passive transponder to receive energy from the interrogating field which energy is used

by the transponder to provide the coded response to the interrogating signal. The activation of a key in the keyboard 60 closes a switch that connects the transponder circuit corresponding to that key to an antenna in the keyboard thereby allowing it to receive energy from the interrogating field 16 and provide a coded response to the reader in the computer housing 14. The transponder circuit provides a unique code identifying the key which is read by the reader and thus provides an identification of the specific key activation to the computer processor. The transponder circuitry may share one or more antennas, coupled via a switch to the common antenna. When a key is activated by the keyboard user the depression of the key closes the switch thereby coupling the transponder circuit to the antenna . This allows the transponder circuit to collect power from the interrogating field and respond with a unique key code to the reader. Depending on the choice of frequency and coupling, a separate tag reader antenna 64 may be provided on or in the housing or monitor 18 (or in a separate module such as module 19 shown in figure 1) for interrogating tag 15 while still sharing some or all of the reader electronics and maintaining the associated cost advantages. E.g., where the wireless keyboard operates in the far field transmission mode and the tag reader operates in a proximity or near field mode. Alternatively, to increase read distance for the tags 15, wireless keyboard 60 may incorporate a tag/smart card contact 62 to couple the tag to a large antenna in the keyboard (illustrated by the dashed line 66 in Fig. 6) thereby greatly increasing the size of the tag antenna and its read distance. This antenna may be shared with keyboard keys or dedicated to powering the tag. Other shared antennas for the keyboard keys are illustrated by the other dashed lines 68 in Fig. 6. For example, one antenna may be provided for each key which is commonly activated; e.g., a separate antenna provided for alt, cntrl, shift, del, and a common antenna provided for the remaining keys. Alternatively, if a suitable anticollision protocol is employed a single large shared antenna may be employed for all the keys. Alternatively, a shared reader may be employed for reading tags and the wireless keyboard and a conventional wired mouse employed.

In the various embodiments described above it will be appreciated that a variety of specific implementations are possible. A number of examples of specific implementations of wireless keyboard and wireless mouse designs are described in US patent application serial number 09/978,615 filed 10/16/01, and in US patent application serial number 10/003,778 filed 10/31/01 the disclosures of which are incorporated herein by reference in their entirety. Also, more conventional active wireless mouse, wireless keyboard or other wireless computer input devices may be employed which share a RFID tag reader electronics or antenna in whole or in part in accordance with the present invention and thereby achieve attendant cost and space savings.

It should be appreciated that where a tag reader, wireless mouse and keyboard are provided together in a computer system, the individual design considerations may be altered to more effectively combine the three components. For example, a wireless keyboard may be able to take advantage of a larger antenna than a wireless mouse and this may affect frequency selection depending on whether shared readers are employed or not. For example, a typical keyboard of about 18 inches would accommodate a key shared half wavelength dipole antenna of about 17 inches operating in the range of 325-350 MHz and would effectively transmit to the reader in backscatter mode. A backscatter mode for a smaller tag or mouse antenna would operate in the GHz range, however, for example in the 2.45 GHz range. Therefore, a shared system might select the higher frequency range. Alternatively, the tag and mouse might employ near field coupling such as inductive coupling or electrostatic coupling and a mouse pad antenna, exploiting the closeness of the mouse pad antenna, whereas the keyboard may employ backscatter far field EM coupling. An optimal shared system might therefore employ two reader antennas and/or frequency ranges, one for near field and one far field, and/or two forms of coupling but a single antenna. Therefore, a system with a tag reader, wireless passive mouse and keyboard may include a keyboard operating at a first frequency and mode (electrostatic or magnetic near field or far

field/backscatter) and a tag reader and mouse operating at a second frequency and/or mode (electrostatic or magnetic near field or far field/backscatter). Furthermore, a system with a tag reader, wireless passive mouse and wireless keyboard may include a shared reader antenna or separate antennas.

As one specific example of a combined system, a wireless keyboard operating in backscatter mode with a half wavelength dipole antenna shared between plural keyboard keys may be employed. A frequency selected based on keyboard and antenna dimensions and/or FCC regulations may be provided, e.g., at 300-350 MHz, 900-930 MHz, 2.4-2.5 GHz or 5.7-5.9 MHz. At the higher frequencies plural antennas or antenna elements may be provided on the keyboard, as shown schematically in figure 6, coupled to different groups of keys or commonly coupled to power supply circuitry to provide increased power to the power supply circuitry. In the case of a separate antenna for the mouse and tags, e.g., a mouse pad antenna, a near field coupling, e.g., magnetic or electrostatic coupling, to the wireless mouse and tag may be provided. Alternatively, the wireless mouse 12 and RFID tag RF transponder circuitry also may operate in a far field backscatter mode and a higher frequency range, e.g., 2.4-2.5 GHz or 5.7-5.9 MHz selected to allow a suitable antenna size configurable within the mouse housing and tag packaging. A separate frequency for each RF circuit of the keyboard, tag and mouse is preferably provided to avoid interference but may be within the same frequency range to allow shared reader circuitry. Separate time slots may be employed for reading each of the keyboard, tag and mouse; i.e., three or more time slots being employed. This may be used instead of separate frequencies or combined with the use of separate frequencies. Both frequency and time slot discrimination are described in more detail in the above noted 09/978,615 and 10/003,778 applications.

Additional variations and modifications will be appreciated by those skilled in the art as being within the teachings of the present invention.